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Urocitellus canus (Rodentia: Sciuridae)

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Abstract: *Urocitellus canus* (Merriam, 1898) is a sciurid commonly called Merriam's ground squirrel. A nondescript, thin-tailed, unmarked ground squirrel, it is 1 of 12 species in the genus *Urocitellus*. It occurs in eastern Oregon and small parts of neighboring Idaho, Nevada, and California. It prefers grasslands and pastures with big sagebrush and western juniper. Although the International Union for Conservation of Nature and Natural Resources places *U. canus* in their Least Concern (LC) category, this species is of conservation concern regionally because of its limited distribution. DOI: 10.1644/834.1.

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Urocitellus canus (Merriam, 1898)
Merriam's Ground Squirrel

Spermophilus mollis canus Merriam, 1898:70. Type locality "Antelope, Wasco County, Oregon [USA]."

[*Citellus mollis*] *canus*: Trouessart, 1904:339. Name combination.

Citellus canus vigilis Merriam, 1913:137. Type locality "Vale [Malheur County], Oregon [USA]."

Citellus mollis vigilis: Bailey, 1936:156. Name combination.

Citellus townsendii vigilis: A. H. Howell, 1938:66. Name combination.

Citellus townsendii canus: A. H. Howell, 1938:67. Name combination.

Spermophilus townsendii canus: Hall and Kelson, 1959:336. Name combination.

C[*itellus*]. *vigilis*: Vorontsov and Lyapunova, 1970:114. Name combination.

Spermophilus townsendii vigilis: Nadler, 1968:144. Name combination.

Spermophilus vigilis vigilis: Nadler, Hoffmann, Vorontsov, Koeppl, Deutsch, and Sukernik, 1982:199. Name combination.

Spermophilus vigilis canus: Nadler, Hoffmann, Vorontsov, Koeppl, Deutsch, and Sukernik, 1982:199. Name combination.

Spermophilus canus: Hoffmann, Anderson, Thorington, and Heaney, 1993:445. Name combination.

Urocitellus canus: Helgen, Cole, Helgen, and Wilson, 2009:297. First use of current name combination.

CONTEXT AND CONTENT. Order Rodentia, suborder Sciuromorpha, family Sciuridae, subfamily Sciurinae, tribe Marmotini (Hall 1981; Helgen et al. 2009; Howell 1938; McKenna and Bell 1997; Thorington and Hoffmann 2005). Two subspecies have been recognized:

U. c. canus (Merriam, 1898:70). See above.
U. c. vigilis (Merriam, 1913:137). See above.

NOMENCLATURAL NOTES. Merriam (1898) 1st recognized *canus* as a subspecies of *Urocitellus mollis*, previously recognized as a species by Kennicott in 1863 (Verts and Carraway 1998). Subsequently, Merriam (1913) named *vigilis* as a subspecies of *canus*, thus elevating *canus* to species status. Merriam used the now invalid generic name

Fig. 1.—Adult *Urocitellus canus* showing characteristic posture. Used with permission of the photographer, Ronald Altig.

Citellus originally proposed by Oken, but rejected by Hershkovitz (1949).

Howell (1938) revised the genus *Spermophilus* and designated *canus*, *mollis*, *vigilis*, and *artemesiae*, a taxon restricted to north of the Snake River in Idaho, as subspecies of *townsendii*. Based on his study of karyotypes, Nadler (1968) separated *U. townsendii* in Washington east and north of the Yakima River from those animals west and south of the river (Verts and Carraway 1998). Nadler (1968) demonstrated differences in karyotypes among some of these races, but Hall (1981) and Rickart (1987) treated the group as a single species (*U. townsendii*). Nadler (1968) and Rickart et al. (1985) examined representative individuals of the subspecies of the *U. townsendii* complex cytologically. Hoffmann et al. (1993) considered the *U. townsendii* complex to consist of 3 species: *U. townsendii*, *U. canus* (including *canus* and *vigilis*), and *U. mollis* (including *artemesiae*, *idahoensis*, *mollis*, and *nancyae*). Thorington and Hoffmann (2005) agreed with this taxonomy with the exception of reallocating *nancyae* as a subspecies of *townsendii*.

Many workers recognized 2 subspecies, *U. c. canus* and *U. c. vigilis* (e.g., Hall 1981; Hoffmann et al. 1993; Wilson and Ruff 1999). However, Thorington and Hoffmann (2005) did not recognize any subspecies. *Urocitellus* was elevated from subgeneric to generic rank by Helgen et al. (2009).

The generic name *Urocitellus* is derived from the Latin *uro* for tail and *citellus* for ground squirrel (Jaeger 1959). The specific epithet *canus* applies to the ash-colored or gray pelage (Brown 1956). Common names for this species include Merriam's ground squirrel, sage squirrel, gray sage squirrel, sage rat, Malheur Valley ground squirrel (*U. c. vigilis*), and speckled sage squirrel (*U. c. vigilis*), among others (Rickart 1999; Verts and Carraway 1998). Verts and Carraway (1998) proposed the vernacular name Merriam's ground squirrel to honor the describer of the taxon, Clinton Hart Merriam.

DIAGNOSIS

Urocitellus canus is a small, gray ground squirrel with short ears, a short, thin tail, and pelage lacking stripes, spots, or flecks (Fig. 1). The fur is short and smooth (Bailey 1936). The darker, dorsal pelage is grayish washed with pinkish buff (Kays and Wilson 2002; Verts and Carraway 1998). The ventral pelage is light buff-white (Bailey 1936). The sides of the head and the hind legs are tinted with pinkish to reddish buff (Howell 1938; Kays and Wilson 2002). The tail is gray on the dorsal side and edged with buff. It is light cinnamon in color on the ventral side.

Urocitellus canus is distinguished from ground squirrels of the genera *Callospermophilus* and *Ictidomys* by the absence of conspicuous dorsal flecks, spots, or stripes. *U. canus* is smaller (typically <250 mm in total body length) and has a shorter tail (about 25% of the length of the head and body) than members of the genera *Poliocitellus*, *Otospermophilus*, and *Xerospermophilus*, which possess tails >33% of the head and body length. *U. canus* is not sympatric with members of the genera *Ictidomys*, *Poliocitellus*, and *Xerospermophilus*, and it can be distinguished easily from *Callospermophilus* by the lack of dorsal stripes. *U. canus* can be distinguished from the North American "big eared" ground squirrels in the genus *Urocitellus* (*armatus*, *beldingi*, *columbianus*, *elegans*, *parryii*, and *richardsonii*) by its smaller body and hind-foot length, shorter ears, and pale pelage lacking stripes, spots, or flecks. *U. canus* has shorter ears, unspeckled pelage, and a longer, narrower rostrum compared with the lightly spotted, longer-eared *U. brunneus*. Unlike *U. washingtoni*, it does not have flecked dorsal pelage.

Urocitellus canus is not distinguishable from *U. townsendii* and *U. mollis* using external characteristics (Kays and Wilson 2002; Rickart 1999). These species are relatively small, have short, inconspicuous ears, short, thin tails, and their pelage is unmarked. The skull of *canus* is shorter and relatively broader than that of *mollis* (Howell 1938). The zygomata spread more widely, the bullae are generally smaller, and the rostrum is relatively shorter and broader compared to *mollis* (Fig. 2).

Howell (1938) reported tail lengths of 37–42 mm for specimens of *U. canus* that he measured, and he considered *canus* smaller than *mollis* for this character. Verts and Carraway (1998) reported a wider range of tail lengths (30–61 mm), which they obtained from museum specimen labels, some of which overlapped with the *mollis* range. We found an intermediate range in tail lengths (31–50 mm) recorded on specimens in the National Museum of Natural History (USNM).

Urocitellus canus vigilis has a greater average body and cranial size than *U. c. canus* (Nadler 1968). *U. c. vigilis* is slightly more buffy than *U. c. canus* (Howell 1938). The skull of *U.* c. *canus* is similar to that of *U. c. vigilis* but smaller. The skull of *U. c. vigilis* is about the same length as that of *U. mollis*, but zygomata are heavier and more widely spreading, rostrum is relatively shorter and broader, and maxillary toothrow is slightly shorter.

GENERAL CHARACTERS

Skull measurements (mm) of *Urocitellus canus* recorded from specimens in the collection of the USNM are given as means and ranges for males and females (in parentheses): condylobasal length, 36.2, 35.0–37.5 (36.4, 34.4–38.7); zygomatic breadth, 23.6, 22.7–24.0 (24.1, 21.7–25.9); interorbital breadth, 7.6, 7.0–8.0 (7.6, 6.9–8.4); breadth of braincase, 17.4, 16.9–18.1 (17.2, 16.4–17.8); length of nasals, 11.8, 10.8–12.7 (11.8, 11.3–13.2); length of maxillary toothrow, 7.6, 7.3–7.9 (7.8, 7.3–8.0); length of mandibular toothrow, 7.3, 6.9–7.9 (7.5, 7.0–7.9); rostrum breadth 7.3,

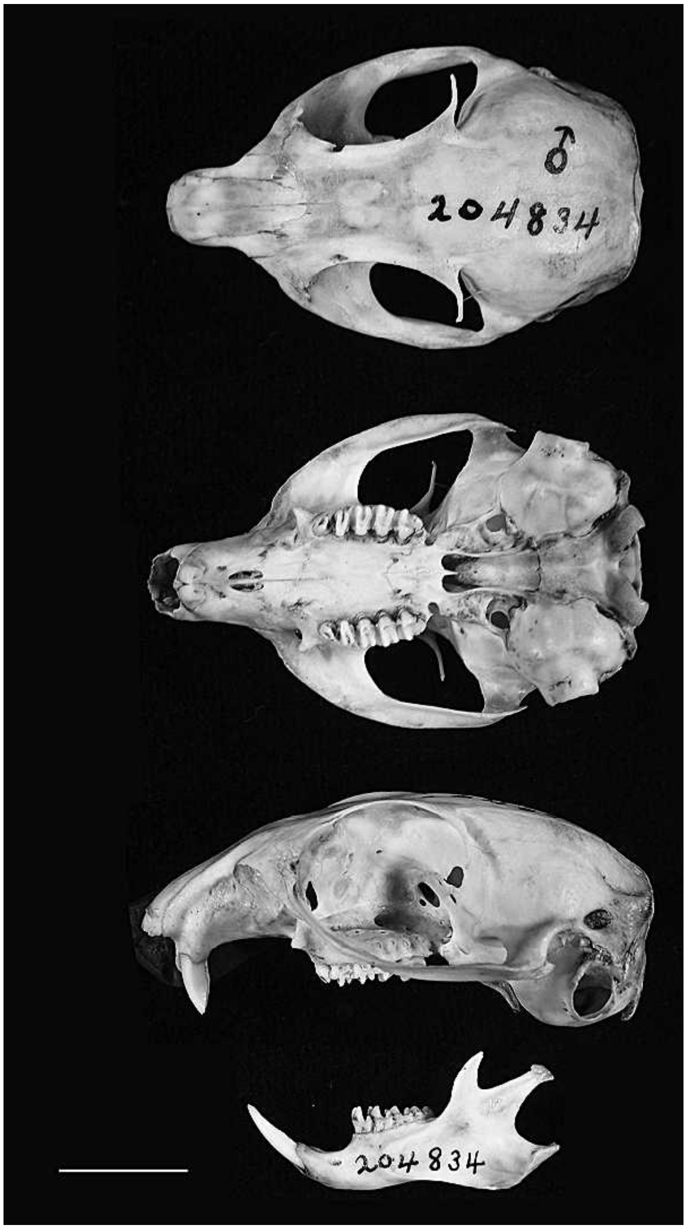

Fig. 2.—Dorsal, ventral, and lateral views of the skull and a lateral view of the lower mandible of a male *Urocitellus canus canus* collected on 29 July 1914 at Bend, west bank of Deschutes River, Oregon (United States National Museum no. 204834). Scale bar equals 10 mm.

6.7–7.8 (7.1, 6.8–7.5); and length of auditory bulla, 8.1, 8.0–8.4 (8.2, 7.8–8.5).

Howell (1938) reported the following skull measurements (mm) for *U. canus* as means and ranges for 10 specimens: greatest length, 36.3, 34.6–38.0; palatilar length, 17.3, 16.5–18.5; zygomatic breadth, 23.9, 23.1–24.5; cranial breadth, 17.6, 17.0–18.2; interorbital breadth, 7.5, 7.0–8.0; breadth of postorbital constriction, 10.1, 9.3–11.0; length of nasals, 12.9, 12.2–13.6; and length of maxillary toothrow, 7.4, 7.0–7.8. Measurements of skull characteristics for male and female *U. canus* also were provided by Verts and Carraway (1998).

Bailey (1936) reported mean external measurements (mm) for 10 adult *U. canus*: total length, 208; length of tail, 40; length of hind foot, 31; and length of ear (dry), 6. External measurements (mm) for 10 specimens of *U. canus* reported by Howell (1938) were: total length, 201.4 (190–217); length of tail (to end of vertebrae), 39.4 (37–42); and length of hind foot, 30.7 (29–33). Measurements of total length and length of hind foot also were reported by Verts and Carraway (1998). External measurements (mm) recorded from specimen tags for *U. canus* in the USNM collections given as means and ranges for males and females (in parentheses) are: total length, 202.9, 188–211 (200.8, 193–218); length of tail, 39.6, 33–49 (41.4, 31–50); and length of hind foot, 31.8, 29–34 (31.2, 30–32).

Skull measurements (mm) of *U. c. canus* recorded from specimens in the USNM collection given as means and ranges for males and females (in parentheses) are: condylobasal length, 36.2, 35.0–37.5 (36.4, 34.4–38.7); zygomatic breadth, 23.6, 22.7–24.7 (24.1 21.7–25.9); interorbital breadth, 7.5, 7.0–7.8 (7.6, 6.2–8.4); breadth of braincase, 17.4, 16.9–18.0 (17.2, 16.4–17.8); length of nasals, 11.8, 10.8–12.7 (11.8, 11.3–13.2); length of maxillary toothrow, 7.6, 7.3–7.9 (7.8, 7.3–8.1); length of mandibular toothrow, 7.3, 6.9–7.9 (7.5, 7.1–7.9); rostrum breadth, 7.3, 6.7–7.8 (7.1, 6.8–7.5); and length of bulla, 8.1, 8.0–8.3 (8.2, 7.8–8.5). Means and ranges for measurements (mm) of 10 skulls of *U. c. canus* reported by Howell (1938) included greatest length, 36.3 (34.6–38.0); palatilar length, 17.3 (16.5–18.5); zygomatic breadth, 23.9 (23.1–24.5); cranium breadth, 17.6 (17.0–18.2); interorbital breadth, 7.5 (7.0–8.0); breadth of postorbital constriction, 10.1 (9.3–11.0); length of nasals, 12.9 (12.2–13.6); and length of maxillary toothrow, 7.4 (7.0–7.8).

Skull measurements (mm) of *U. c. vigilis* recorded from specimens in the USNM collection and given as means and ranges for males and females (in parentheses) are: condylobasal length, 35.0, 34.7–36.8 (35.5, 33.2–36.9); zygomatic breadth, 23.9, 22.9–25.5 (24.9, 23.1–26.6); interorbital breadth, 7.6, 7.0–7.9 (7.8, 7.4–8.4); breadth of braincase, 17.6, 16.9–18.0 (17.6, 17.0–18.2); length of nasals, 12.2, 11.6–12.7 (12.2, 11.1–12.9); length of maxillary toothrow, 8.0, 7.7–8.5 (7.9, 7.4–8.5); length of mandibular toothrow, 7.5, 7.1–7.9 (7.4, 6.8–7.9); rostrum breadth, 7.0, 6.7–7.4 (7.0, 6.8–7.2); and length of bulla, 8.5, 8.2–9.0 (8.6, 8.2–9.0). Means and ranges of measurements (mm) of 13 skulls of *U. c. vigilis* reported by Howell (1938) included: greatest length, 38.3 (37.3–39.6); palatilar length, 18.4 (17.5–19.5); zygomatic breadth, 25.5 (24.5–26.7); cranium breadth, 17.8 (17.2–18.4); interorbital breadth, 7.9 (7.3–8.4); breadth of postorbital constriction, 9.6 (8.9–10.5); length of nasals, 13.4 (12.8–13.8); and length of maxillary toothrow, 7.7 (7.2–8.2). Most skull measurements (mm) average slightly larger for *U. c. vigilis* versus *U. c. canus*: breadth of braincase (17.6 versus

17.3), length of nasals (12.2 versus 11.8), length of maxillary toothrow (8.0 versus 7.7), and length of bulla (8.5 versus 8.2). The only exception was rostrum breadth, which was less (7.0 versus 7.2) for *U. c. vigilis* than for *U. c. canus*.

External measurements (mm) recorded from specimen tags for *U. c. canus* given as means and ranges for males and females (in parentheses) included: total length, 202.9, 188–211 (200.8, 193–218); length of tail, 39.6, 33–44 (41.4, 31–50); and length of hind foot, 31.8, 29–34 (31.2, 30–32). Mean external measurements (mm) of 10 specimens of *U. c. canus* reported by Howell (1938) were: total length, 201.4 (190–217); length of tail to end of vertebrae, 39.4 (37–42); and length of hind foot, 30.7 (29–33). External measurements for *U. c. vigilis* included: total length, 217.0, 205–238 (222.4, 201–251); length of tail, 45.4, 35–52 (45.0, 35–51); and length of hind foot, 33.4, 30–35 (32.6, 29–37). Mean external measurements (mm) of 10 specimens of *U. c. vigilis* reported by Howell (1938) were: total length, 226.2 (201–238); length of tail to end of vertebrae, 44.4 (35–52); and length of hind foot, 33.1 (31–35). We recorded greater average external measurements (mm) for *U. c. vigilis* than for *U. c. canus*, including differences of 9% for total length (201.9 versus 219.7), 12% for length of tail (40.5 versus 45.2), and 5% for length of hind foot (31.5 versus 33.0).

Adult body mass varies seasonally and is smallest as squirrels emerge from hibernation and largest as they enter hibernation. Males are typically heavier than females. Verts and Carraway (1998) reported means and ranges of mass for individuals caught in northern Malheur County, Oregon: males (n = 18) 196.6 g (146.0–300.2 g) and females (n = 12) 171.7 g (143.8–210.0 g). They also reported a mean weight of 134.7 g for males (n = 21) collected in the remainder of Oregon.

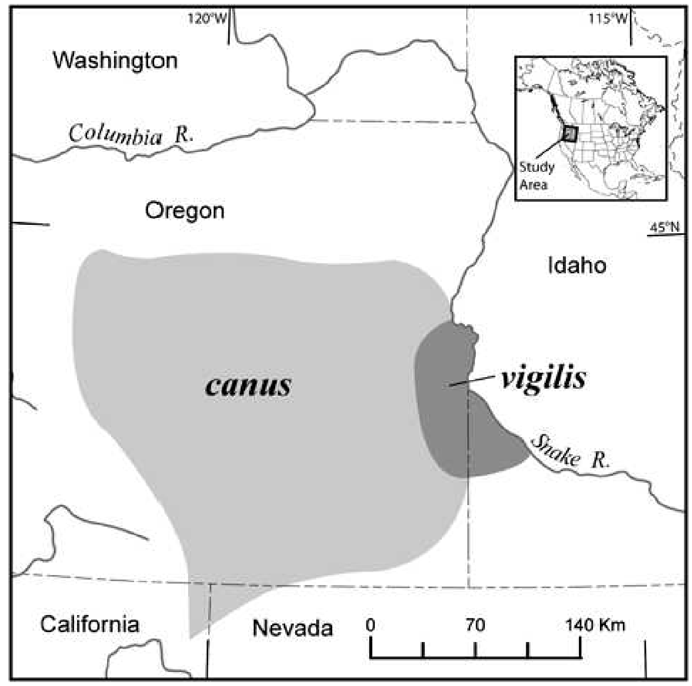

Fig. 3.—Geographic distribution of *Urocitellus canus*: distribution of *U. c. canus* and *U. c. vigilis* indicated by differences in shading; map from Rickart et al. (1985) with modifications.

DISTRIBUTION

The geographic range of *Urocitellus canus* extends over much of eastern Oregon, except the northeastern and southeastern corners of the state (Fig. 3). The range continues south to extreme northwestern Nevada and northeastern California and east to the western shore of the Snake River in extreme west-central Idaho (Hall 1946; Rickart 1999; Thorington and Hoffmann 2005). Verts and Carraway (1998) described the northern and western limits of *U. canus* as a line connecting Huntington, Baker County; North Powder, Union County; Squaw Butte, Wheeler County; Maupin, Wasco County; Warm Springs, Jefferson County; Bend, Deschutes County; and Fort Rock, Summer Lake, and Plush, Lake County. This species does not occur south of the North Fork Owyhee River in southern Malheur County, Oregon (Verts and Carraway 1998).

Two subspecies are recognized by most mammalogists: *U. c. canus* and *U. c. vigilis*. *U. c. canus* occurs in central Oregon east to Harney County. *U. c. vigilis* has a limited distribution within the Snake River drainage along the Oregon–Idaho border in extreme eastern Oregon in Malheur County and parts of Owyhee County, and in extreme west-central Idaho (Bailey 1936; Davis 1939a, 1939b; Rickart 1999; Wilson and Ruff 1999; Yensen 2001). No fossils are known.

FORM AND FUNCTION

Rickart (1989) investigated the renal structure and urine concentrating capacity in 4 taxa drawn from the *Urocitellus townsendii* complex of ground squirrels (*U. mollis*, *U. canus vigilis*, *U. m. artemesiae*, and *U. m. idahoensis*). There were no differences in renal structure as measured by medullary thickness and body size or soil salinity and 3 other measurements of habitat aridity (total precipitation, biotemperature, and the ratio of potential evapotranspiration to precipitation). There was no relationship between urine osmolality and body size for these taxa. Urine osmolality was correlated with soil salinity but not other measurements of habitat aridity. Mean (± SE) percent medullary thickness for *U. c. vigilis* was 71.1 ± 0.9 (range: 69.2–75.4; n = 7). Mean (± SE) urine osmolality (mosmol/kg) after 4 days without water was 2,940 ± 116 (range: 2,585–3,220; n = 5), suggesting that these hibernating ground squirrels do not have poor renal efficiency.

The dental formula is i 1/1, c 0/0, p 2/1, m 3/3, total 22. The cheek teeth are hypsodont and P3 is medium sized.

ONTOGENY AND REPRODUCTION

Urocitellus canus gives birth to 1 litter/year (Bailey 1936). The time needed in a typical season for young to grow, mature, and get fat in preparation for hibernation in early August precludes a 2nd litter within a season. Based on emergence dates for young, most litters are born in late April or early May. One autopsy of a pregnant female caught in late April yielded 9 embryos with a crown-rump length of 30 mm (Verts and Carraway 1998). Gestation and lactation each typically lasts 3–4 weeks in ground squirrels (Yensen and Sherman 2003). Although exact data are lacking, gestation length tends to be toward the shorter end of that range for smaller ground squirrels such as *U. canus*.

Although data on litter size are scarce, *U. canus* possesses 5 pairs of mammae—1 inguinal, 2 abdominal, and 2 pectoral, suggesting 5–10 young/litter at birth (Bailey 1936). Bailey (1936) reported observing and studying a litter of 8 *U. c. vigilis* on the west bank of the Snake River near Ontario, Oregon.

ECOLOGY

Population characteristics.—Ground squirrel populations occur at a range of densities depending on food and habitat availability. Typical densities for adults before the weaning of juveniles are <20 animals/ha. Densities can expand temporarily to >50 animals/ha after juveniles are weaned (Yensen and Sherman 2003). Size of ground squirrel populations often fluctuates from year to year. These fluctuations may be influenced by winter weather, hibernacula availability, disease, abundance of predators, and variation in food supply (Yensen and Sherman 2003). No detailed population dynamics studies have been conducted on *U. canus*.

Space use.—*Urocitellus canus* occurs in the Upper Sonoran Life Zone, where it typically lives in habitats dominated by big sagebrush (*Artemisia tridentata*), western juniper (*Juniperus occidentalis*), and greasewood (*Sarcobatus vermiculatus*—Wilson and Ruff 1999). This species is abundant in fields, along fence lines, on levee banks, and ditch banks, among sagebrush and boulders, and on valley slopes and hillsides (Bailey 1936). *U. canus* also may be associated with agricultural lands, where it can damage crops.

Typically, *U. c. canus* occupies arid high-desert communities of sagebrush, shadscale (*Atriplex*), or greasewood (*Sarcobatus*—Rickart 1987). This subspecies inhabits well-drained soils such as ridge tops and hillsides, and may be common along canal and railroad embankments and on abandoned farmland. *U. c. vigilis* has a restricted range within river valley bottomlands. Davis (1939a) reported that *U. c. vigilis* was abundant along the west bank of the Snake River near Ontario, Oregon, where it inhabited disturbed and pasture lands.

Bailey (1936) reported that *U. canus* inhabited sagebrush habitat and grain and alfalfa fields in the Malheur and Owyhee river valleys along the Oregon–Idaho border. Feldhamer (1979) caught *U. canus* in areas dominated by big sagebrush and greasewood, but not in marsh or grassland habitats. However, Verts and Carraway (1998) reported *U. canus* in pastures, grasslands, and occasionally in big sagebrush–western juniper habitat. A colony of *U. canus* occupying a 1- to 2-m rimrock area east of Christmas Lake, Lake County, Oregon, also was reported by these authors.

Diet.—Bailey (1936) reported that many green plants, roots and bulbs, seeds and grains, and a variety of insects are eaten by *Urocitellus canus*. Plants include agricultural crops such as alfalfa, clover, various grasses and grains, and other forage crops. *U. canus* has been observed feeding on flower heads of sunflowers (probably *Helianthus*), alfilaria (*Erodium*), and various legumes and other composites (Bailey 1936). Bailey (1936) indicated that in areas where cicadas were numerous, *U. canus* preferred them as a food item. He suggested that as the season progresses, these animals concentrate on storing sufficient fat reserves to survive the hibernation period.

Bailey (1936) suggested that *U. c. canus* does not contact agriculture over most of its range, but *U. c. vigilis* commonly invades cultivated areas and can cause extensive damage to crops. Davis (1939a, 1939b) reported that *U. c. vigilis* fed largely on native vegetation but observed animals feeding in a field of alfalfa adjacent to their burrows. *U. c. vigilis* may be a common pest in agricultural fields and cause crop damage (Verts and Carraway 1998). Maser and Shaver (1976) reported that a *U. canus* with severely maloccluded incisors fed by cutting grass blades with its molars.

Interspecific interactions.—Over much of its range, *Urocitellus canus* lives in semidesert habitats and does not conflict with agriculture to the extent seen in some other species of ground squirrels. However, *U. canus* and other ground squirrels inhabiting agricultural lands historically have been poisoned, shot, trapped, and generally eradicated by farmers and ranchers (Yensen and Sherman 2003). Although small animals, their abundance in some areas makes them agricultural pests. As native habitat is converted for agriculture, *U. canus* is likely to come into further conflict with human activities. Human persecution because of an exaggerated and often unwarranted reputation as agricultural pests is common (Kays and Wilson 2002).

Burrowing activity by *U. canus* and other small mammals can alter soil properties and processes. Burrowing by ground squirrels can increase water infiltration into the soil profile; soil water recharge was higher in burrow areas than in nonburrow areas, and recharge amounts were positively related to burrow density (Laundre 1993). Ground squirrel burrowing also facilitated deeper water penetration into the soil profile. In addition to increasing water infiltration, burrowing by small mammals can help aerate the soil profile, influence mineralization rates, redistribute inorganic nutrients in the root zone, and increase plant productivity (Green and Reynard 1932; Laundre 1998). Plant storage and defecation in burrows can enhance the organic content of soils (Chew 1978; Taylor 1935). These deposits may increase water retention, nitrogen levels, and anion exchange capacity of the soil (Laundre 1993).

Remains of *U. canus* have been found in regurgitated pellets of barn owls (*Tyto alba*) near Vale, Malheur County, Oregon (Maser et al. 1980), and great horned owls (*Bubo virginianus*) on the Crooked River National Grasslands, Jefferson County, Oregon (Maser et al. 1970). It is likely that a variety of predatory birds (hawks and a few owl species), carnivores (e.g., badgers [*Taxidea taxus*], coyotes [*Canis latrans*], long-tailed weasels [*Mustela frenata*], and skunks [*Mephitis mephitis*]), and large snakes prey on this species. Bailey (1936) mentioned that badgers dig *U. canus* out of its burrows. Bailey (1936) suggested that *U. canus* might be used as a human food source.

In many aspects the biological and ecological attributes of *U. canus* resemble those of the Piute ground squirrel, *U. mollis* (Rickart 1999). Primary research studies on the biology and ecology of *U. canus* are scarce and investigations of the natural history of this species should be encouraged.

BEHAVIOR

Urocitellus canus is quiet and secretive, with a soft, lisping whistle or a long, shrill squeak when alarmed (Bailey 1936). Its pelage coloration enables it to be cryptic in its environment. *U. canus* is diurnal. Timing of its annual hibernation cycles may differ within and among populations. Variation in cycles is influenced by winter weather, spring snow cover, latitude, and elevation (Verts and Carraway 1998). Ground squirrels inhabiting xeric habitats where the availability of green vegetation depends on spring rains and the summers are hot and dry may emerge earlier in spring and enter hibernation by midsummer (Yensen and Sherman 2003). Loss of mass during hibernation may be considerable, but once above ground the animals gain weight rapidly and have significant layers of fat by early summer (Bailey 1936). As with most species of ground squirrels, soil temperature is a likely trigger for emergence from hibernation. Adults taken in late May were fat and almost ready to hibernate (Davis 1939a).

These ground squirrels may climb bushes while feeding or may pull plants down to eat the new growth (Davis 1939a, 1939b). *U. canus* is a good swimmer, may cross some water barriers, and may enter water voluntarily where it seems to possess a keen sense of direction (Davis 1939a, 1939b). The adult animals he observed showed a crepuscular activity pattern, but the young were active for most of the day.

Urocitellus canus has a brief annual period of above-ground activity. Typically, adults emerge from hibernation in early March (Bailey 1936). The single litter is produced in late April or early May. Davis (1939b) reported taking half-grown young of the year of *U. c. vigilis* in late May in Ontario, Oregon. This observation suggests that the mating season may begin in early March in some years. By early August, this species has become dormant, with adults going into their hibernaculum 1st followed by the young of the year (Bailey 1936; Rickart 1999). Bailey (1936) reported that most animals had entered their hibernacula by mid-July at 1 location near Riverside, Malheur County, Oregon.

Urocitellus canus digs burrows under sagebrush or out in the open. Animals remain near burrow entrances, if rapid escape from danger is necessary (Bailey 1936). When disturbed, the animal typically dives into its burrow and may stay underground, where it remains for a few minutes up to several hours. The animal reemerges cautiously and stands on its hind legs near the burrow entrance to survey the area to assess the danger before resuming its activity, typically gathering food. Ditch banks are a favored location for burrows, but plowed agricultural fields and dry meadows provide alternative burrow sites, if ample food is available nearby. These animals appear gregarious, in part, because they gather on suitable soils and near preferred food sources (Bailey 1936). Burrow locations (for *U. c. vigilis*) vary from riverbanks to hillsides (Bailey 1936).

Young appear to dig a burrow with only 1 entrance initially (Davis 1939a). Home burrows for adult breeding squirrels may have as many as 8 openings. By late May, adults were crepuscular in behavior pattern; however, young were active most of the day (Davis 1939b).

Home-range size for ground squirrels may differ with season, sex, and local food availability (Yensen and Sherman 2003). Although variable, the typical ground squirrel home range is <1 ha. Adult males occupy larger home ranges than those of other sex and age groups. Adults have little overlap with individuals of the same sex, but are more tolerant of the opposite sex and of young.

GENETICS

Nadler (1966, 1968) reported the diploid number (2n) for *Urocitellus canus canus* and for *U. c. vigilis* as 46. The karyotype for *U. c. canus* consists of 12 metacentric, 12 submetacentric, and 20 acrocentric autosomes and a submetacentric X chromosome and an acrocentric Y chromosome; the fundamental number (FN) is 68. The karyotype for *U. c. vigilis* consists of 12 metacentric, 10 submetacentric, and 22 acrocentric autosomes and a submetacentric X chromosome and a small acrocentric Y chromosome; the fundamental number is 66 (Nadler 1968).

Along the northwestern limit of its range, *U. mollis* approaches the range of *U. canus* (Rickart et al. 1985). Howell (1938) reported morphological intergradation between populations of *U. canus* and *U. mollis* in southern Malheur County in southeastern Oregon. Although hybridization may occur between *U. canus* and *U. mollis*, Rickart et al. (1985) found no cytological evidence of intergradation among these taxa and suggested that the zone of overlap, if it exists, is probably narrow because of the proximity of chromosomally differentiated populations. No hybridization between *U. canus* (2n = 46) and *U. mollis* (2n = 38) or *U. townsendii* (2n = 36) has been reported (Rickart et al. 1985; Thorington and Hoffmann 2005). Rickart et al. (1985) suggested that the most probable area where hybridization might occur is in the Snake River Valley between Marsing and Murphy in Idaho. Potential hybridization between these species in southeastern Oregon is likely hindered by the Steens, Sheepshead, and Cedar mountains.

CONSERVATION

Ground squirrels are keystone species in their ecosystems and their loss can disrupt normal ecosystem functions (Yensen and Sherman 2003). Ground squirrels loosen, aerate, and move soils, and help translocate nutrients from deep in the soil to the soil surface. Burrowing by ground squirrels influences soil fertility, water infiltration, plant species composition, and primary production. Unfortunately, many farmers and ranchers consider ground squirrels pests, and eradication efforts are common. Overgrazing facilitating the invasion of exotic plant species and a great probability of fires has reduced protective cover, changed microclimate, and influenced availability of preferred food items. Habitat conversion for agricultural use also has removed thousands of acres of potential habitat for this species. Ground squirrel habitat has been so disrupted by urban sprawl and conversion to agricultural use that current sites might represent a fraction of the original range (Yensen and Sherman 2003). Populations of *U. canus* have declined and populations have become increasingly isolated by habitat disturbance and destruction (Yensen and Sherman 2003). The probability of recolonizing former habitat is low because of the isolation of populations. Although the International Union for Conservation of Nature and Natural Resources places *U. canus* in their Least Concern (LC) category (International Union for Conservation of Nature and Natural Resources 2008), this species is considered a species of conservation concern by some biologists (Yensen and Sherman 2003).

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LITERATURE CITED

Bailey, V. 1936. The mammals and life zones of Oregon. North American Fauna 55:1–416.

Brown, R. W. 1956. Composition of scientific words. Smithsonian Institution Press, Washington, D.C.

Chew, R. M. 1978. The impact of small mammals on ecosystem structure and function. Pp. 167–180, in Population of small mammal under natural conditions (D. P. Snyder, ed.). Pymatuning Laboratory of Ecology Special Publication, 5:1–237.

Davis, W. B. 1939a. The recent mammals of Idaho. Caxton Printers, Caldwell, Idaho.

Davis, W. B. 1939b. The Townsend ground squirrels of Idaho. Journal of Mammalogy 20:182–190.

Feldhamer, G. A. 1979. Vegetation and edaphic factors affecting abundance and distribution of small mammals in southeast Oregon. Great Basin Naturalist 39:207–218.

Green, R. A., and C. Reynard. 1932. The influence of two burrowing rodents, *Dipodomys spectabilis* (kangaroo rat) and *Neotoma albigula albigula* (pack rat) on desert soils in Arizona. Ecology 13:73–80.

Hall, E. R. 1946. Mammals of Nevada. University of California Press, Berkeley.

Hall, E. R. 1981. The mammals of North America. John Wiley & Sons, Inc., New York.

Hall, E. R., and K. R. Kelson. 1959. The mammals of North America. Ronald Press Co., New York.

Helgen, K. M., F. R. Cole, L. E. Helgen, and D. E. Wilson. 2009. Generic revision in the Holarctic ground squirrel genus *Spermophilus*. Journal of Mammalogy 90:270–305.

Hershkovitz, P. 1949. Status of names credited to Oken, 1816. Journal of Mammalogy 30:289–301.

Hoffmann, R. S., C. G. Anderson, R. W. Thorington, Jr., and L. R. Heaney. 1993. Family Sciuridae. Pp. 419–466 in Mammal species of the world: a taxonomic and geographic reference (D. E. Wilson and D. M. Reeder, eds.). 2nd ed. Smithsonian Institution Press, Washington, D.C.

Howell, A. H. 1938. Revision of the North American ground squirrels, with a classification of North American Sciuridae. North American Fauna 56:1–256.

International Union for Conservation of Nature and Natural Resources. 2008. Red list of treatened species. www.iucnredlist.org, accessed 12 April 2009.

Jaeger, E. C. 1959. A source-book of biological names and terms. 3rd ed. Charles C. Thomas Publisher, Springfield, Illinois.

Kays, R. W., and D. E. Wilson. 2002. Mammals of North America. Princeton University Press, Princeton, New Jersey.

Laundre, J. W. 1993. Effects of small mammal burrows on water infiltration in a cool desert environment. Oecologia 94:43–48.

Laundre, J. W. 1998. Effect of ground squirrel burrows on plant productivity in a cool desert environment. Journal of Range Management 51:638–643.

Maser, C., E. W. Hammer, and S. H. Anderson. 1970. Comparative food habits of three owl species in central Oregon. Murrelet 51: 29–33.

Maser, C., and C. Shaver. 1976. Acute incisor malocclusion in a Townsend ground squirrel. Murrelet 57:17–18.

Maser, C., S. Shaver, and B. Price. 1980. A note on the food habits of the barn owl in Malheur County, Oregon. Murrelet 61:78–80.

McKenna, M. C., and S. K. Bell. 1997. Classification of mammals above the species level. Columbia University Press, New York.

Merriam, C. H. 1898. Descriptions of six new ground squirrels from the western United States. Proceedings of the Biological Society of Washington 12:69–71.

Merriam, C. H. 1913. Six new ground squirrels of the *Citellus mollis* group from Idaho, Oregon, and Nevada. Proceedings of the Biological Society of Washington 26:135–138.

Nadler, C. F. 1966. Chromosomes and systematics of American ground squirrels of the subgenus *Spermophilus*. Journal of Mammalogy 47:579–596.

Nadler, C. F. 1968. The chromosome of *Spermophilus townsendii* (Rodentia: Sciuridae) and a report of a new subspecies. Cytogenetics 7:144–157.

Nadler, C. F., R. S. Hoffmann, N. N. Vorontsov, J. W. Koeppl, L. Deutsch, and R. I. Sukernik. 1982. Evolution in ground squirrels. II. Biochemical comparisons in Holarctic populations of Spermophilus. Zeitschrift für Säugetierkunde 47:198–215.

Rickart, E. A. 1987. *Spermophilus townsendii*. Mammalian Species 268:1–6.

Rickart, E. A. 1989. Variation in renal structure and urine concentrating capacity among ground squirrels of the *Spermophilus townsendii* complex (Rodentia: Sciuridae). Comparative Biochemistry and Physiology, A. Comparative Physiology 92:531–534.

Rickart, E. A. 1999. Merriam's ground squirrel. P. 415 in The Smithsonian book of North American mammals (D. E. Wilson and S. Ruff, eds.). Smithsonian Institution Press, Washington, D.C.

Rickart, E. A., R. S. Hoffmann, and M. Rosenfeld. 1985. Karyotype of *Spermophilus townsendii artemesiae* (Rodentia: Sciuridae) and chromosomal variation in the *Spermophilus townsendii* complex. Mammalian Chromosome Newsletter 26:94–102.

Taylor, W. P. 1935. Some animal relations to soils. Ecology 16: 127–136.

Thorington, R. W., Jr., and R. S. Hoffmann. 2005. Family Sciuridae. Pp. 754–818 in Mammal species of the world: a taxonomic and geographic reference (D. E. Wilson and D. M. Reeder, eds.). 3rd ed. Johns Hopkins University Press, Baltimore, Maryland.

Trouessart, E.-L. 1904. Catalogus mammalium tam viventium quam fossilium. R. Friedlander & Sohn, Berlin, Germany.

Verts, B. J., and L. M. Carraway. 1998. Land mammals of Oregon. University of California Press, Berkeley.

Vorontsov, N. N., and E. A. Lyapunova. 1970. Khromosomnye chisla i vidoobrazovanie u nazemnykh belich'ikh (Sciuridae: Xerinae et Marmotinae) Golarktiki [Chromosome number and species formation in ground squirrels of the Holarctic]. Byulleten' Moskovskovo Obshchestva Ispytatelei Prirody, Otdel Biologicheskii 75:112–126 (in Russian).

Wilson, D. E., and S. Ruff. 1999. The Smithsonian book of North American mammals. Smithsonian Institution Press, Washington, D.C.

Yensen, E. 2001. The ecological role of ground squirrels and a "field guide" to northwestern species. Journal of the Idaho Academy of Science 37:42–44.

Yensen, E., and P. W. Sherman. 2003. Ground squirrels. Pp. 211–231 in Wild mammals of North America: biology, management, and conservation (G. A. Feldhamer, B. C. Thompson, and J. A. Chapman, eds.). 2nd ed. Johns Hopkins University Press, Baltimore, Maryland.

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